

## Module 4 - Steady State Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

### Topic 1 - Components, Units, and Symbols

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- Common Passive Components
- Important Electrical Quantities
- Units and Symbols
- Types of Switches

# Common Passive Components

Passive components affect the behavior of a circuit in different ways but they do not generate power and can only absorb energy or transform it into heat. Active components on the other hand...

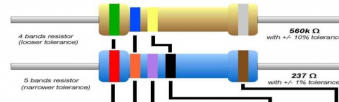
- Resistor
- Capacitor
- Inductor

Most circuits require an active power source for operation. A voltage source is used in most applications however current sources are also available and are needed for specialized electrical applications.

# Common Passive Components

Components are identified by color codes and numbering systems. However it is always a good idea to measure for yourself because a marking can be incorrect or a component may be damaged.

**Resistor Color Code**



| Color  | 1 <sup>st</sup> Band | 2 <sup>nd</sup> Band | 3 <sup>rd</sup> Band | Multiplier           | Tolerance    |
|--------|----------------------|----------------------|----------------------|----------------------|--------------|
| Black  | 0                    | 0                    | 0                    | $\times 1 \Omega$    |              |
| Brown  | 1                    | 1                    | 1                    | $\times 10 \Omega$   | $\pm 1\%$    |
| Red    | 2                    | 2                    | 2                    | $\times 100 \Omega$  | $\pm 2\%$    |
| Orange | 3                    | 3                    | 3                    | $\times 1K \Omega$   |              |
| Yellow | 4                    | 4                    | 4                    | $\times 10K \Omega$  |              |
| Green  | 5                    | 5                    | 5                    | $\times 100K \Omega$ | $\pm 0.5\%$  |
| Blue   | 6                    | 6                    | 6                    | $\times 1M \Omega$   | $\pm 0.25\%$ |
| Violet | 7                    | 7                    | 7                    | $\times 10M \Omega$  | $\pm 0.1\%$  |
| Grey   | 8                    | 8                    | 8                    |                      | $\pm 0.05\%$ |
| White  | 9                    | 9                    | 9                    |                      |              |
| Gold   |                      |                      |                      | $\times 1 \Omega$    | $\pm 5\%$    |
| Silver |                      |                      |                      | $\times 0.1 \Omega$  | $\pm 10\%$   |

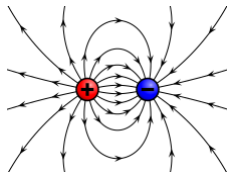
Codes of Ceramic Disc Capacitor

[www.circuitspedia.com](http://www.circuitspedia.com)

| Picofarad<br>pF | Nanofarad<br>nF | Microfarad<br>μF | CODE | Picofarad<br>pF | Nanofarad<br>nF | Microfarad<br>μF | CODE |
|-----------------|-----------------|------------------|------|-----------------|-----------------|------------------|------|
| 10              | 0.01            | 0.00001          | 100  | 4700            | 4.7             | 0.0047           | 472  |
| 15              | 0.015           | 0.000015         | 150  | 5000            | 5.0             | 0.005            | 502  |
| 22              | 0.022           | 0.000022         | 220  | 5600            | 5.6             | 0.0056           | 562  |
| 33              | 0.033           | 0.000033         | 330  | 6800            | 6.8             | 0.0068           | 682  |
| 47              | 0.047           | 0.000047         | 470  | 10000           | 10              | 0.01             | 103  |
| 100             | 0.1             | 0.0001           | 101  | 15000           | 15              | 0.015            | 153  |
| 120             | 0.12            | 0.00012          | 121  | 22000           | 22              | 0.022            | 223  |
| 130             | 0.13            | 0.00013          | 131  | 33000           | 33              | 0.033            | 333  |
| 150             | 0.15            | 0.00015          | 151  | 47000           | 47              | 0.047            | 473  |
| 180             | 0.18            | 0.00018          | 181  | 68000           | 68              | 0.068            | 683  |
| 220             | 0.22            | 0.00022          | 221  | 100000          | 100             | 0.1              | 104  |
| 330             | 0.33            | 0.00033          | 331  | 150000          | 150             | 0.15             | 154  |
| 470             | 0.47            | 0.00047          | 471  | 200000          | 200             | 0.2              | 204  |
| 560             | 0.56            | 0.00056          | 561  | 220000          | 220             | 0.22             | 224  |
| 680             | 0.68            | 0.00068          | 681  | 330000          | 330             | 0.33             | 334  |
| 750             | 0.75            | 0.00075          | 751  | 470000          | 470             | 0.47             | 474  |
| 820             | 0.82            | 0.00082          | 821  | 680000          | 680             | 0.68             | 684  |
| 1000            | 1.0             | 0.001            | 102  | 1000000         | 1000            | 1.0              | 105  |
| 1500            | 1.5             | 0.0015           | 152  | 1500000         | 1500            | 1.5              | 155  |
| 2000            | 2.0             | 0.002            | 202  | 2000000         | 2000            | 2.0              | 205  |
| 2200            | 2.2             | 0.0022           | 222  | 2200000         | 2200            | 2.2              | 225  |
| 3300            | 3.3             | 0.0033           | 332  | 3300000         | 3300            | 3.3              | 335  |

## Important Electrical Quantities

- **Charge** - the physical property of matter that causes it to experience a force when placed in an electromagnetic field.



- **Voltage** - the difference in electric potential between two points ... can be caused by electric charge, by electric current through a magnetic field, by time-varying magnetic fields, or some combination of these three.
- **Current** - the rate of flow of electric charge past a point or region. An electric current is said to exist when there is a net flow of electric charge through a region.

## Important Electrical Quantities

- **Resistance** - a measure of a components opposition to the flow of electric current. The inverse quantity is electrical conductance, and is the ease with which an electric current passes.
- **Capacitance** - the ratio of the change in electric charge of a system to the corresponding change in its electric potential (voltage).
- **Inductance** - the tendency of an electrical conductor to oppose a change in the electric current flowing through it. The flow of electric current creates a magnetic field around the conductor. The field strength depends on the magnitude of the current, and follows any changes in current.

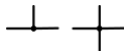
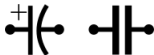
## Units and Symbols

| Quantity    | Symbol | Unit    | Abbr.    |
|-------------|--------|---------|----------|
| Charge      | Q,q    | Coulomb | C        |
| Voltage     | V,v    | Volt    | v        |
| Current     | I,i    | Ampere  | A        |
| Resistance  | R      | Ohm     | $\Omega$ |
| Capacitance | C      | Farad   | F        |
| Inductance  | L      | Henry   | H        |

Question: When should you use upper case or lower case letters for electrical quantities?

# Units and Symbols

When working with a or building a circuit you need a diagram. Draw or find one before you begin. Here are some commonly used symbols.





# Types of Switches

A switch is a mechanical-electrical device that that can change from a continuous state to a dis-continuous state and they are used as a mechanical interface to a circuit. There many different types of switches for different purposes and this is not an exhaustive list.

- Toggle Switches
- Momentary Switches
- Reed Switches
- Level or Float Switches
- and many more

# Types of Switches

Toggle switches are possibly the most commonly used switches and they come in many different forms.

**Poles** - The numbers of poles refers to the number of independent conductors or circuits in a switch that are controlled by the same toggle or input.

**Throws** - The numbers of throws refers to the number of output terminals of a switch per pole.

